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The Future of Food in Ethiopia: Sustainable Solutions

Ethiopia's food insecurity stems from the misfortune of severe droughts in the country. Some solutions, such as delivering food to those who are severely food insecure, help families recuperate. However, future planning is vital to achieving sustainability. Options exist to help plants withstand dry land, such as greenhouses, hydroponics, and crop rotation. Solutions like these help recover the barren land and offer long-term solutions to recurring problems.

Ethiopia, a country within the horn of East sub-Saharan Africa, has vast geography ranging from "dry desert steppe vegetation" within the Denakil plain to "tropical thickets wooded steppe" within the rift valley (Marcus). Additionally, there are areas of mountain vegetation in the high altitudes of the western and eastern highlands of "montane and temperate grasslands" (Britannica). Only 20% of the country is urban, mainly in the capital Addis Ababa (Alemayehu). The population is around 114 million and steadily increasing within urban areas (with 3.6 million living in the capital), but decreasing in the rural areas ("Country"). Around 384.76 square kilometers of land is cultivated, with Ethiopia's main crops being teff, wheat, maize, sorghum, and barley (Galal, Taffesse 28). The average size of a farm is around 100,000 square feet, which is approximately one and a half times as big as the U.S. Whitehouse (Heady). An average family of 5-6 people lives in a house where walls are made of mud or mortar, and a tin or thatched roof ("Ethiopia-Housing", Saleh). Those in bigger cities like Addis Ababa live in either substandard housing or are homeless. A typical family's diet consists of cereals, legumes, vegetables, fruit, and milk generally from rain-fed farms or local markets ("The facts", Selinus). Average jobs in agriculture, mining, and chemicals generate an average wage of $19,505 a year ("Working in Ethiopia", "Ethiopia Salary"). Healthcare is free but hard to come by in remote regions (Marcus, "Ethiopia Healthcare"). Less than half the population has access to clean water, adequately maintained sanitation, electricity, telephones, and properly maintained roads (Smith, "Ethiopia - Country", "Ethiopia Internet"). The major barriers families face when it comes to obtaining nutritious food are climate change and extreme droughts that ruin crops and soil ("The facts"). Droughts and floods also displace families and leave people in poverty.

Ethiopia is severely impacted by hunger; the percentage of the population living in hunger is 24.9% ("Global Food"). Approximately 25.6 million people are challenged with insufficient food consumption ("Hunger Map Live"). 5.5 million people were severely food insecure in Tigray and surrounding regions as of June 2021 ("UN Agencies"). These 5.5 million people could easily slip into starvation.
The future of Ethiopia is troubling since 36.8% of children under five are affected by severe malnutrition ("UN Agencies").

The main misfortune causing hunger is extreme droughts in the area that leave the environment in critical condition. Crop production has dropped from 50 to 90% in some regions ("Record-Breaking Drought" 1). Droughts have caused crop failure that has "decimated livestock" since 2016 and left 10.2 million food insecure ("Record-Breaking Drought" 1). 4.5 million livestock, which supports families, have died due to lack of water and pasture (Wentworth).

Most Ethiopian food sources are rainfed crops, meaning that drought threatens the main food sources. Droughts have also driven families out of their homes, potentially taking away their jobs and leading them into poverty when they can no longer pay for food.

Humanitarian needs have tripled since the beginning of 2015 due to droughts (“Ethiopia Urgently” 1). The increased need for humanitarian aid shows that the affected people of Ethiopia are not currently getting what they need. As of 2022, drought conditions were the worst of the past 40 years (Wentworth). These droughts affect every aspect of life and heighten other tensions. As of April 2021, the government has “...declared a state of emergency in Amhara State…” after multiple attacks from Ethiopia’s Federal Government and Tigray people's Liberation Front (“War in Ethiopia”).

The current drought is the worst since 1981; 25.6 million people suffer from insufficient food consumption. The World Food Programme has made efforts to help lessen the impact of droughts on the citizens of Ethiopia. “WFP provides unconditional food and cash transfers to the most vulnerable families across Ethiopia” (“Ethiopia.”). Delivering food and cash is a major help for families in need in these areas since they could be fleeing their homes due to conflict or severe drought. After a family is assisted multiple times, help can and should transition away from needing to rely on emergency services (”Ethiopia.”). A routine of emergency assistance relies heavily on resources donated, so not all people in need might get the donations due to a lack of resources. Additionally, conflict prevents many from acquiring food and money transfers (“Ethiopia.”).

Addis Ababa, and multiple other cities within Ethiopia, are faced with “highly stressed and unsustainable” water systems (Beker and Kansal). Increasing populations and urbanization are threats to infrastructure, which includes drinking water systems (Beker and Kansal). “Changing hydroclimatic conditions, population growth, changing socioeconomic conditions, government decisions, and various policies" are all important factors for the urban drinking water systems (UDWS) of Ethiopia (Beker and Kansal). There is a noticeable gap between water supply and demand in the cities of Ethiopia, showing that there is continuous struggle for any area of the country (Beker and Kansal). One case study of the major Ethiopian cities (Addis Ababa, Adama, Mekelle, and Dire Dawa) show that high/low pressure, water loss, water shortage and source pollution severely affect the water distribution network (Beker and Kansal). Additionally, the case study found that “...in Addis Ababa alone, potable water is only accessible to 66% of the city population…” (Beker and Kansal). Furthermore, over 35% of freshwater produced is either lost or unaccounted for (Beker and Kansal). The researchers that conducted this study have hypothesized that water management systems could help the recent difficulties of the water distribution system/network (Beker and Kansal). A dam is one form of a water management system used various other times in Ethiopia, such as the Aswan High Dam. REACH, the global research programme dedicated to improving water quality, has “...sought to increase the storage and treatment plant capacity of dams, to construct additional surface water supply sources, and to drill additional deep wells" in response to the findings (REACH).

Ethiopia has almost completed a project launched in 2011; The Grand Ethiopian Renaissance Dam (GERD), a dam built on the Nile that is seen as “a gift to generations” (Aljazeera). The GERD is a hydroelectric dam that could generate more than 5,000 megawatts of power, which would double Ethiopia's production of electricity. At 1.1 miles long and 476 feet high, the dam cost $4.2 billion dollars; it has been funded by the people and government of Ethiopia (Water Technology). The Metals and Engineering Corporation (METEC), an industrial company in Ethiopia, helped supply electromechanical equipment for the project after an engineering procurement and construction (EPC) contract was awarded (Water Technology). The GERD will irrigate Ethiopian land and reduce sediment and flooding in Sudan (Water Technology). It is projected to reduce alluvium (silt) in Sudan by 100 million cubic meters and facilitate irrigation of approximately 500,000 ha of new agricultural land (Water Technology). The regulated flow of the dam is expected to reduce around 40 km of flooding in Sudan, and to reduce the “impact of evaporation of water from the dam” (Water Technology). Other dams in Ethiopia address around 19 billion cubic meters of evaporation. The construction of the new dam can reduce the capacity needed from those dams and decrease their evaporation (Water Technology). For instance, the Aswan High Dam (located in Ethiopia) will have its water capacity reduced as a result of the GERD, saving

about six billion cubic meters of water (Water Technology). The Gafsara Dam is the current source of drinking water for the capital Addis Ababa; ideally, the new GERD can provide another source of drinking water for the population (Ethiopian Institute for Strategic Studies). Despite these positive projections, more measures are needed to plan for a healthier future.

To address food insecurity in the long-term, sustainable farming procedures are needed to accommodate the unfavorable climate and weather of the region. Crop rotation means that, instead of consistently growing the same crop repeatedly, a farmer changes between multiple types of crops. There are many benefits to this practice. There is more variety in the types of food for a community, and rotations benefit soil health. Plots of land that support crop rotation have improved soil health, optimized nutrients, and can combat pest and weed pressure ("Crop Rotations"). A study in North America found that diverse rotations of crops increased maize yield by 28.1% on average (Bowles). The same study asserted that, in areas of drought, yield losses were reduced by 14.0% - 89.9% (Bowles). Many farms in North America use this technique with good results. In studies conducted in Alabama and Tennessee, areas with rotations showed an 11% increase in yield between the years 1995 and 2005 (Stalcup 1). In some regions of Sub-Saharan Africa, crop rotation is being used and resulting in an increase in yield. "Soy-maize rotations increase SSA cereal yields by an average of 0.49 tons/hectare or more in fields planted after a legume when compared to cereals in continuous cultivation" (Liana Acevedo-Siaca and Goldsmith 5). The newly built GERD can support crop rotation by providing water for land. Crop rotation keeps soil healthy and the new irrigation system with the dam can help turn the coarse land into a better setting for cultivation. Ethiopian highlands are the most advisable area to cultivate in Ethiopia. "The Ethiopian highlands comprise nearly 45 percent of the total land area and support over 85 percent of the country's 64 million people…" (Ouda and Zohry). Utilizing this area for crop rotation can conclude in a higher yield with less water wasted. Despite evident positive results, resistance may exist because his technique requires effort and planning and costs more than continuously planting the same crop.

Greenhouses offer another way of accommodating the dry climate of Ethiopia. Greenhouses create perfect temperature, and atmospheric conditions for plants to grow all year round. The main benefit of greenhouses is that they can shrink water use by 90% (Peters). The Netherlands is a good example of a location benefiting from this technology. There it is used on a large scale for a very high yield (Peters). According to USDA data, the average yield of tomatoes in a greenhouse was 10.59 pounds per square foot, whereas, for traditionally grown tomatoes, the yield was 1.85 pounds per square foot ("Commercial Greenhouse"). The implementation of greenhouses also creates jobs. Greenhouses require sources of water, which can be provided by the GERD. Greenhouses can take advantage of water from the GERD while also shrinking usage. Companies like the Pastoral and Environmental Network in the Horn of Africa (PENHA), and Hydroponics Africa Limited provide greenhouses for various African countries. PENHA works with countries with issues similar to Ethiopia in water scarcity. It has sold specialized seawater greenhouses to Somaliland that are said to slowly help areas become more self-sufficient in fresh produce production (PENHA). Hydroponics Africa Limited is a "sole distributor of a superior subsurface plant responsive drip in East and Central Africa" (Hydroponics Africa). Since 2012, the company has sold more than 365 greenhouses to African countries, and specializes in various types of farming technology (SWFF). Hydroponics can work well with greenhouse technology, and fortunately such systems are also supplied through this company. PENHA has sold over 700 hydroponic fodder systems with greenhouses, and trained more than 2,200 people to work with the sustainable systems that are continuously helping populations grow food (SWFF).

Hydroponics "is the technique of growing plants using a water-based nutrient solution rather than soil" (Smeulders). Greenhouses are used to pilot hydroponics on both small and large scales. In Zambia, 23 greenhouses are modeling this new way of growing food (Smeulders). "Each greenhouse shields around 2,000 plants which produce an estimated 1,300 kg of vegetables per month" (Smeulders). Containers for the plants can be made of plastic bags, buckets, or recycled bottles. So any individual can have the ability

to create their own personal farm (Smeulders). Hydroponics is being taught in Zambia's schools and surplus crops create income to help sustain the gardens (Smeulders). Data shows that hydroponics uses zero soil, 75% less space, and the same amount of water as a traditional greenhouse ("H2Grow"). The growth rate of hydroponics is 100% times greater than that of traditional agriculture ("H2Grow"). Crops can be consumed and sold to provide income that helps a community escape hunger ("H2Grow"). Fodder for animals can also be grown (Popovska). Well-fed animals can provide meat and milk for a more nutritious diet, as well as another source of income (Popovska). As referenced in the previous paragraph, the company Hydroponics Africa Limited sells hydroponic systems with the potential to feed many people. Systems range in cost from $100 to $4,800; some of the smaller and cheaper systems can feed a family of "five to eight members" (SWFF). The company creates agreements with surrounding banks to give small loans to their buyers that can be paid off in about 8 months (SWFF). The long-term use of hydroponics and consistent production of food will profit owners, whether they decide to sell their food or keep it. Those who do not sell their food will still benefit from improved nutrition and increased production (SWFF). Those who chose to sell their food can sell it in the market, improving their income (SWFF). This cost-effective and sustainable food-growing technique is the future of food growth.

Hydroponics, crop rotation, and greenhouses are appropriate technology for Ethiopia since they all can use water from dams and storage systems or rain. In Ethiopia, the mean annual rainfall is approximately "2,000 mm over the south-western highlands and less than 300 mm over the south-eastern and north-eastern lowlands" (CCKP). This equates to over 78 inches of rain in the highlands, and less than 12 inches of rain in the lowlands. Although it is a very small and insufficient amount of rainwater, with the technologies mentioned the Ethiopian population can use the water to its fullest capacity and stretch resources for a longer period of time. LSU College of Agriculture explains that hydroponic systems use 4 gallons of water per square foot per year, while soil based systems use 8 gallons per square foot per year (Mendoza and Adhikari)). Switching to hydroponics can save half of the water used in a regular soil farm. A study in Egypt showed that, together with crop rotation, over 1000 cubic meters per hectare of water can be saved (Ouda and Zohry). In addition to the rain water collected, dam water can be used to provide irrigation for these farms.

The aforementioned ideas and solutions are very important to the food security of Ethiopia and all depend on the education of its population. Those who will actively use hydroponics, crop rotation, and greenhouses must be effectively taught how the technologies work. Spreading knowledge of these newly adopted solutions will benefit others in a community. Each of these 3 technologies are almost certainly going to be used in Ethiopia's future. Benefit would come from involving schools in educating young people about farming techniques. Schools in at-risk areas should add this to their curricula, using school gardens for students to observe the processes of small-scale farming. The students learning these techniques will be the future of farming.

Hydroponics, crop rotation, and greenhouses are all key to food security in Ethiopia. A combination of these methods and technologies will lessen the impact of droughts on communities. Through these techniques, Ethiopia's farms can produce higher yields, conserve water, recondition land, and support the economy. This is the future of Ethiopia's sustainable agriculture.

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